WHAT IS CLAIMED IS

Sub A1

~~1. A semiconductor device, characterized by:~~

~~a Si crystal having a (111) surface; and~~

~~an insulation film formed on said (111) surface of said Si crystal,~~

~~at least a part of said insulation film comprising a Si oxide film containing Kr.~~

2. A semiconductor device as claimed in claim 1, wherein said Si oxide film has a surface state density of $10^{11} eV^{-1} cm^{-2}$ or less.

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~~3. A semiconductor device as claimed in claim 1, wherein a Kr concentration level decreases in said Si oxide film from a surface of said Si oxide film to an interface between said Si oxide film and said Si crystal.~~

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4. A semiconductor device as claimed in

claim 1, characterized in that said Si oxide film contains Kr with a surface density of $5 \times 10^{11} cm^{-2}$ or less at a surface thereof.

5. A semiconductor device as claimed in claim 1, further having a gate electrode on said Si oxide film.

6. A semiconductor device as claimed in claim 1, wherein said crystal surface is formed on a part of a device isolation groove formed on a Si substrate.

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7. A semiconductor device as claimed in claim 1, wherein said crystal surface forms a principal surface of said Si substrate.

8. A semiconductor device as claimed in claim 1, wherein said crystal surface is formed on a surface of a polysilicon film.

9. A semiconductor device characterized by:

a Si crystal having a crystal surface near a (111) surface; and

an insulation film formed on said crystal surface,

at least a part of said insulation film comprising a silicon nitride film containing Ar or Kr.

10. A semiconductor device as claimed in claim 9, characterized in that said Si nitride film contains Ar or Kr with a surface density of 5 x $10^{11}cm^{-2}$ or less.

11. A semiconductor device as claimed in claim 9, characterized in that said Si nitride film contains hydrogen atoms therein.

12. A semiconductor device as claimed in claim 6, characterized by further comprising a gate electrode on said Si nitride film.

13. A semiconductor device as claimed in claim 9, wherein said (111) is formed on a part of a device isolation groove formed on a Si substrate.

14. A semiconductor device as claimed in claim 9, wherein said (111) surface formed a principal surface of a Si substrate.

15. A semiconductor device as claimed in claim 9, wherein said (111) surface is formed on a surface of a polysilicon film.

16. A semiconductor device, comprising:

a Si substrate;

a device isolation groove formed on said Si substrate; and

an insulation film covering a surface of said Si substrate and a sidewall surface of said device isolation groove continuously;

said insulation film comprising a Si oxide film having a uniform thickness.

17. A semiconductor device as claimed in claim 16, wherein said Si oxide film contains Kr on a surface thereof with a surface density of $5 \times 10^{11} cm^{-2}$ or less.

18. A semiconductor device as claimed in claim 16, wherein a Kr concentration level decreases in said Si oxide film from a surface thereof to an interface to said Si substrate.

19. A semiconductor device as claimed in claim 16, wherein said Si oxide film has a thickness of about 2.1 nm or less.

20. A semiconductor device, comprising:

a Si substrate;

a device isolation groove; and

an insulation film covering a surface of said Si substrate and a sidewall surface of said device isolation groove continuously,

said insulation film comprising a Si nitride film containing Ar or Kr.

21. A semiconductor device as claimed in claim 20, wherein said Si oxide film contains Ar or Kr on a surface thereof with a surface density of 5 x $10^{11}cm^{-2}$ or less.

22. A semiconductor device as claimed in claim 20, wherein said Si nitride film has a thickness of about 2.1 nm or less.

23. A polysilicon transistor, characterized by:

an insulation film;

a polysilicon film formed on said insulation film;

a gate insulation film formed on said polysilicon film; and

a gate electrode formed on said gate insulation film,

said gate insulation film comprising a Si oxide film containing Kr.

24. A polysilicon transistor, characterized by:

an insulation film;

a polysilicon film formed on said insulation film;

a gate insulation film formed on said polysilicon film; and

a gate electrode formed on said gate insulation film, said gate insulation film comprising a Si nitride film containing Ar or Kr.

25. A flash memory device, comprising:

a Si substrate;

a first insulation film formed on said Si substrate;

a floating gate electrode of polysilicon formed on said first insulation film;

a second insulation film formed on said floating gate electrode; and

a control gate electrode formed on said second insulation film,

said second insulation film comprising a Si oxide film containing Kr.

26. A flash memory device, comprising:

a Si substrate;

a first insulation film formed on said Si substrate;

a floating gate electrode of polysilicon formed on said first insulation film;

a second insulation film formed on said floating gate electrode; and

a control gate electrode formed on said second insulation film,

said second insulation film comprising a Si nitride film containing Ar or Kr.

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27. A ferroelectric memory device, characterized by :

a Si substrate;

a gate insulation film formed on said Si substrate;

a gate electrode of polysilicon formed on said gate insulation film;

a Si nitride film formed on said gate insulation film; and

a ferroelectric film formed on said Si nitride film; and

another electrode formed on said ferroelectric film,

said Si nitride film containing Ar or Kr.

28. A semiconductor integrated circuit device, comprising:

at least one metal layer;

a Si layer formed above said metal layer with an insulation film interposed therebetween, said

Si layer having a (111) principal surface; and

a plurality of transistors formed on said Si layer,

at least a part of said insulation film formed on a surface of said silicon layer comprising a Si oxide film containing Ar.

29. A semiconductor integrated circuit, comprising:

at least one metal layer;

a Si layer formed above said metal layer with an insulation film interposed therebetween, said Si layer having a (111) principal surface; and

a plurality of transistors formed on said Si layer,

at least a part of said insulation film formed on a surface of said silicon layer comprising a silicon nitride film containing Ar or Kr.

30. A method of forming a Si oxide film comprising the steps of:

forming plasma by introducing an inert gas predominantly of Kr and an oxygen gas into a processing chamber and causing excitation therein by a microwave; and

oxidizing a crystal surface of a Si crystal in the vicinity of a (111) surface by atomic state

oxygen O* formed with excitation of said plasma.

31. A method of forming a Si oxide film as claimed in claim 30, wherein said oxidation step is conducted at a temperature of 550°C or less.

32. A method of forming a Si oxide film as claimed in claim 30, wherein said oxidation step is conducted at a temperature of about 400°C.

33. A method of forming a Si nitride film, comprising the steps of:

forming plasma by introducing an inert gas predominantly of Ar or Kr and a gas containing nitrogen as a constituent element into a processing chamber and causing a excitation therein by a microwave; and

nitriding a crystal surface of a Si crystal in the vicinity of a (111) surface by hydrogen nitride radicals NH* formed with excitation of said plasma.

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34. A method of forming a Si nitride film as claimed in claim 33, wherein said oxidation step is conducted at a temperature of 550°C or less.

35. A method of forming a Si nitride film as claimed in claim 33, wherein said oxidation step is conducted at a temperature of about 400°C.

36. A method of forming a device isolation structure, comprising the steps of:

forming a device isolation groove defined by a sidewall surface on a surface of a Si substrate;

depositing an oxide film on said surface of said Si substrate so as to fill said device isolation groove;

exposing said surface of said Si substrate and a top part of said sidewall surface of said device isolation groove;

oxidizing said exposed surface of said Si substrate and said top part of said device isolation groove including a corner part at a top edge of said sidewall surface of said device isolation groove, to form anther oxide film such that said another oxide film covers said surface of said Si substrate and said exposed part of said sidewall surface of said device isolation groove continuously,

said another oxide film being formed by the

steps of:

forming plasma by exciting an inert gas predominantly of Kr and an oxygen gas by a microwave; and

oxidizing said surface of said Si substrate and said exposed part of said sidewall surface of said device isolation groove by atomic state oxygen O* formed with excitation of said plasma.

37. A method of forming an oxide film on a polysilicon pattern, characterized by the steps of:

forming a polysilicon pattern on an insulation film; and

oxidizing a surface and a sidewall of said polysilicon film to form an oxide film such that said oxide film covers said surface and said sidewall of said polysilicon film continuously,

said step of forming said oxide film comprising the steps of:

forming plasma by exciting an inert gas predominantly of Kr and an oxygen gas by a microwave; and

oxidizing a surface of said polysilicon film by atomic state oxygen O* formed with excitation of said plasma.

38. A method of forming a nitride film on a

polysilicon pattern, characterized by the steps of:

forming a polysilicon pattern on an insulation film; and

forming a nitride film by nitriding a surface and sidewall of said polysilicon film such that said nitride film covers said surface and said sidewall of said polysilicon film continuously;

said step of forming said nitride film comprising the steps of:

forming plasma by exciting an inert gas predominantly of Ar or Kr and a gas containing nitrogen as a constituent element by a microwave; and

nitriding a surface of said polysilicon film by hydrogen nitride radicals NH* formed with excitation of said plasma.

39. A method of forming a ferroelectric film, comprising the steps of:

depositing a ferroelectric film on a substrate; and

crystallizing said ferroelectric film,

said step of crystallizing said ferroelectric film comprising the steps of:

forming plasma by exciting an inert gas predominantly of Kr and an oxygen gas by a microwave; and

exposing said ferroelectric film to atomic state oxygen O* formed with excitation of said plasma.

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